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(54) Title of the Invention: Polyester-based conjugate fiber
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Specification

1. Title of the Invention
Polyester-based conjugate fiber

2. Claims
(1) A polyester-based conjugate fiber characterized by a conjugate fiber comprising two types of polyester intimately in contact in parallel or eccentrically along the entire length of the fiber, wherein one is a polyester (A) primarily of ethylene terephthalate unit, and the other is a polyester (B) co-polymerized with 0.2 – 1 mol% of pentaerythritol, said conjugate fiber having a latent crimpability to manifest coiled crimps of 35 ea/25 mm or more and a heat shrinkability of 10% or less in heat treatment for unrestricted shrinkage at 170°C.

3. Detailed Explanation of the Invention
(Field of Industrial Use)
This invention relates to a polyester-based conjugate fiber having a latent crimpability suitable for obtaining bulky yarn or non-woven cloth with superior stretchability and elastic recoverability.

(Prior Art)
Generally, polyester-based fibers excel in mechanical characteristics, thermal stability, wash resistance and the like, and are used in many applications. Of such applications, polyester-based fibers used in woven cloths for sportswear and the like, or in non-woven cloths such as padding require in particular stretchability and elastic recoverability.

Heretofore, stretchability was provided on woven cloth and the like by weaving or knitting together yarn made by stranding and jacketing spun yarn with rubber or polyurethane fiber. However, rubber and polyurethane are costly, have too much stretchability, and are difficult to dye.

Another example is to use a highly shrinkable synthetic fiber as spun yarn which is later relaxed by heat treatment. However, shrinking may be inadequate owing to the spreading resistance due to stranding of the spun yarn, or the shrinkability may be drastically reduced by twist setting the spun yarn through heat treatment, and a woven cloth with sufficient stretchability has not yet been obtained.

Non-woven cloth used for sportswear and poultice substrates also requires stretchability and elastic recoverability. A method has been proposed to invest non-woven cloth with stretchability by using conjugate fibers which have three-dimensionally structured coiled crimps. In other words, the non-woven cloth is manufactured by blending a binder fiber with a conjugate fiber having latent crimpability made by spinning yarn using two or more differing shrinkable polymers. Many proposals have been made, for example conjugate spinning of polyesters having differing degrees of polymerization, or conjugate spinning of homopolyester and polyester made by co-polymerizing bifunctional and trifunctional compounds. An example is a conjugate yarn of polyester made by co-polymerizing isophthalic acid and homopolyester. In order to use such conjugate fiber having latent crimpability as bulky yarn or bulky fabric by providing crimp manifesting treatment, the raw stock must be provided with good crimp manifestability, crimp retainability, and an optimum number of crimps.

However, although the conjugate fiber in the prior art, combining isophthalic acid co-polymerized polyester and polyethylene terephthalate, has crimp manifestability, the heat shrink ratio is high so that the surface shrink ratio during heat treatment when making non-woven cloth is high. Also, the non-woven cloth thus obtained is inferior in stretchability and elastic recovery.

Laid-open patent applications Nos. 61 – 70012 and 62 – 78214 additionally disclose examples of conjugate fiber combining polyethylene terephthalate and co-polymerized polyester comprising primarily ethylene terephthalate co-polymerized with structural units having metallic sulfonate groups. However, non-woven cloth obtained from such conjugate fiber, when used for example as a poultice substrate, has the possibility of inhibiting the effects of the medicament through reaction between 5 – sodium sulfoisophthalic acid (hereinafter abbreviated as SIP), which is a co-polymerizing constituent, and the poultice constituent. Further, the cost of SIP is high.

(Problem to be Solved by the Invention)
The purpose of the invention is to provide a low-cost, polyester-based conjugate fiber which has high crimp manifestability and crimp retainability, and which is suitable for obtaining bulky yarn or non-woven cloth with superior stretchability and elastic recovery. A further purpose is to provide a polyester-based conjugate fiber which is inert towards poultice medicament.

(Means to Solve the Problem)
As a result of assiduous investigation in order to solve the problem, the inventors achieved this invention having discovered that the use of ethylene terephthalate co-polymerized with a specific amount of inexpensive pentaerythritol as one constituent of a polyester-based conjugate fiber achieved, at a low rate of modification, a level of crimp manifestability and crimp retainability equivalent for example to the polyester-based conjugate fiber having SIP co-polymerized polyester as one constituent, which is known in the prior art. It was also unexpectedly discovered that a conjugate fiber suitable as a substrate for poultices and the like could be obtained.

The invention is a polyester-based conjugate fiber characterized by a conjugate fiber comprising two types of polyester intimately in contact in parallel or eccentrically along the entire length of the fiber, wherein one is a polyester (A) primarily of ethylene terephthalate unit, and the other is a polyester (B) co-polymerized with 0.2 – 1 mol% of pentaerythritol, said conjugate fiber having a latent crimpability to manifest a coil crimp of 35 ea/25 mm or more and a heat shrinkability of 10% or less in a unrestricted shrinkage heat treatment at 170°C.

The polyester-based conjugate fiber of the invention has a polyester (A) composed primarily of ethylene terephthalate and a polyester (B) co-polymerized with pentaerythritol as a constituent placed in parallel or eccentrically and has latent crimpability which manifests coiled crimps when given relaxation treatment.

The co-polymerized polyester (A) composed primarily of ethylene terephthalate is preferably polyethylene terephthalate, but may contain a small amount of co-polymerizing constituents. In polyester (B) co-polymerized with pentaerythritol, the ratio of pentaerythritol in the co-polymer must be 0.2 – 1 mol%, and preferably 0.3 – 0.8 mol%. The crimp manifestability is inadequate at less than 0.2 mol%. When the ratio exceeds 1 mol%, single filaments or the fibers are apt to break during spinning so that spinning and spooling becomes difficult.

The polyester forming the basic framework of this polyester (B) has no particular restriction as long as it is co-polymerized with a specific amount of pentaerythritol, as described above; for example, polyester comprising ethylene terephthalate units or butylene terephthalate units and modified with pentaerythritol may be used. If cost is taken into consideration, pentaerythritol modified polyethylene terephthalate is preferable.

The co-polymerizing constituent pentaerythritol is less expensive than the SIP mentioned above. Moreover, where SIP requires a 3 – 6 mol% modification ratio in order to manifest for example 50 ea/25 mm or more crimp count after heat treatment (laid-open patent application No. 62 – 78214), pentaerythritol can create an equivalent effect at a third or less modification ratio.

The conjugate form is not restricted in particular, but a side-by-side type is preferable to an eccentric sheath-core type in that the crimp manifestability is superior.

Also, in order to obtain bulky fabric or non-woven cloth, the raw stock must have a coiled crimp manifestability of at least 35 ea/25 mm or more. Such crimps are generated by treating by wet or dry heat the conjugate fiber comprising a combination of (A) and (B) mentioned above, and it is possible to control the number of crimps to some extent by the heat treatment temperature. In this invention, conjugate fiber generating a crimp count of 35 ea/25 mm at 160°C or higher is preferred.

Further, the conjugate fiber in this invention has a heat shrinkage ratio of 10% or less when shrunk unrestrictedly by heat treatment at 170°C. If the ratio exceeds 10%, the woven or non-woven cloth may harden or the durability of the stretchability may deteriorate.

The conjugate fiber in this invention can be manufactured using normal melt spinning equipment and spin drawing with methods known in the prior art. However, in order to effectively provide the latent crimpability of said fiber, the temperature of the constant length heat treatment after drawing should be set at about 120 - 180°C, preferably 140 - 180°C.

It is preferable that the raw stock obtained from the conjugate fiber in this invention not generate unopened sections or neps during carding; in order to prevent this, it is preferable to provide mechanical crimping to the fiber. Generally, the generation of unopened sections or neps have a close relationship to the number and form of crimps; in mechanical crimping, unopened sections are

apt to be generated with the number of crimps is less than 7 ea/25 mm, and neps are apt to be generated when the number of crimps exceeds 20 ea/25 mm. Therefore, it is preferred that 7 – 20 ea/25 mm of mechanical crimps be provided on the conjugate fiber having latent crimpability in this invention. Stuffing box and heated gear methods may be used to provide mechanical crimps; generally, the stuffing box method is good.

The conjugate fiber in this invention may contain various modifiers such as sheen enhancing agents, antistat agents, matting agents, aromatic agents, flame retardants, and the like. Also, the cross-sectional shape may be circular or modified, such as T-shaped, dogbone-shaped, triangular, and the like.

(Working Examples)
The invention is explained in detail below using working examples. Measuring methods used on the working examples and comparative examples are as follows:

- Limiting viscosity [η]: Measured at 30°C in a solvent mixture of phenol and tetrachloroethane (weight ratio 1:1).
- Number of crimps: Measured in accordance with JIS L-1015-7-12-1.
- Size: Measured in accordance with JIS L-1015-7-5-1A.
- Heat shrink ratio: Measured in accordance with JIS L-1015-7-15.

Working Examples 1 – 4, Comparative Example 1
Polyethylene terephthalate with [η] of 0.625 was used as polyester (A) and polyethylene terephthalate-based co-polymerized polyester co-polymerized with 0.15 – 0.8 mol% of pentaerythritol was used as polyester (B) to spin side-by-side type conjugate yarn having a conjugate weight ratio of 1:1 (Table 1).

Table 1

	[η]		Ratio of co-polymerized pentaerythritol (mol%)
	A	B	
Working Example 1	0.625	0.495	0.8
Working Example 2	0.625	0.515	0.6
Working Example 3	0.625	0.525	0.4
Working Example 4	0.625	0.535	0.3
Comparative Example 1	0.625	0.555	0.15

The spinning and drawing conditions were constant for all examples: spinning temperature 285 - 290°C, nozzle 0.55 mmOD x 900H, discharge rate A/B = 0.33/0.33 (g/min-aperture), spooling speed 1000 m/min, drawing temperature 70°C, drawing expansion rate 2.5 – 3.0 times, and constant length heat treatment temperature 140 - 160°C. Table 1 shows the viscosity of each polymer used in spinning, and Table 2 shows the performance of the fibers obtained in the examples. In Table 1, the crimp manifestability of Comparative Example 1 was small because the amount of pentaerythritol co-polymerized was outside the range of the invention.

Table 2

	Size (d)	Raw Stock Mechanical Crimp Count (ea/25 mm)	Heat Shrink Ratio 170°C	Crimp Count After Heat Shrinkage 160°C x 1 min (ea/25 mm)
Working Example 1	2.2	14.0	2.8	55
Working Example 2	2.1	13.3	3.2	48
Working Example 3	2.2	13.0	2.8	45
Working Example 4	2.1	12.8	3.0	38
Comparative Example 1	2.3	13.4	2.3	31

Comparative Example 2
Conjugate fiber was spun in the same manner as Working Examples 1 – 4 except that a polyethylene terephthalate-based polyester co-polymerized with 1.2 mol% of pentaerythritol ([η] = 0.48) was used. Breakage of single filaments or the fiber occurred during spinning and it was difficult to spool.

Reference Example
Conjugate fiber comprising polyethylene terephthalate having [η] of 0.54 co-polymerized with 0.3 mol% of 5 – sodium sulfoisophthalic acid and polyethylene terephthalate having [η] of 0.625 was obtained in the same manner as Working Example 1. The fiber had a crimp count after heat treatment at 160°C x 1 minute of 27 ea/25 mm and did not have good crimp manifestability.

(Effect of the Invention)
When the polyester-based conjugate fiber obtained through the invention was used as bulky yarn or non-woven cloth for padding, particularly in material for sportswear, it showed good stretchability and elastic recoverability

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